

IN THE CLAIMS:

Please cancel Claims 4, 15 and 26 without prejudice to or disclaimer of the subject matter contained therein.

Please amend Claims 1, 7, 9, 12, 18, 20, 23, 29 and 31 as follows.

1. (Currently Amended) A method of ~~generating instructions for~~ rendering a directed acyclic graph into a raster pixel image having a plurality of pixel locations, the directed acyclic graph comprising one or more parent nodes and one or more leaf nodes, each parent node representing an operator and having branches to respective descendent nodes, and each leaf node representing a graphic object having object edges, said method comprising the steps of:

determining groups of one or more pixel locations, wherein the groups are bounded by the object edges;

determining, for each group, a portion of the directed acyclic graph in accordance with activities of the operators, wherein the portion of the directed acyclic graph is that portion which passes data up the directed acyclic graph;

traversing, for each group, the determined portion of the directed acyclic graph, and generating, for each group, instructions for the ~~determined~~ traversed portion of the directed acyclic graph, wherein operator instructions are generated for those operators of the ~~determined~~ traversed portion of the directed acyclic graph having active branches and wherein leaf instructions are generated for those graphic objects which are active at the group of one or more pixel locations; and

executing, for each group, the generated instructions to render the graphic objects at the one or more pixel locations.

2. (Previously Presented) A method according to claim 1, wherein said method further comprises the step of generating a table for storing data concerning the activity of the operators and the activity of the branches of the parent nodes.

3. (Previously Presented) A method according to claim 2, wherein said determining step includes the sub-step of updating, for each group, the data stored in the generated table.

4. (Cancelled)

5. (Previously Presented) A method according to claim 1, wherein the directed acyclic graph is an expression tree.

6. (Previously Presented) A method according to claim 1, wherein the parent nodes represent binary operators.

7. (Currently Amended) A method of ~~generating instructions for~~ rendering an expression tree into a raster pixel image having a plurality of pixel locations, the expression tree having a plurality of nodes comprising one or more binary nodes and a plurality of leaf nodes, wherein each binary node has a left branch to a descendent node and a right branch to another

descendent node and represents a binary operation on the two descendant nodes, and wherein each node represents a graphic object having object edges, with one or more of the graphic objects overlapping, the overlapping graphics objects comprising a left node region, a common region, and a right node region, said method comprising the steps of:

determining groups of one or more pixel locations, wherein the groups are bounded by the object edges;

determining, for each group, whether the left and right branches of the one or more binary nodes are active or inactive; and

traversing, for each group, the expression tree, wherein ~~the left branch of any previously traversed binary node is ignored unless~~ said traversing step comprises the substeps of:

checking whether the right and left branches of ~~the~~ a previously traversed binary node are active or a left node region is required for the binary operation of the previously traversed binary node and the left branch is active and the right branch is inactive of the previously traversed binary node, and if so, traversing the left branch of the previously traversed binary node to the descendent node; and ~~wherein a right branch of any previously traversed binary node is ignored unless~~

checking whether the right and left branches of the previously traversed binary node are active or a right node region is required for the binary operation of the previously traversed binary node and the right branch is active and the left branch is inactive of the previously traversed binary node, and if so, traversing the right branch of the previously traversed binary node to the descendent node; and

generating, for each group, operator instructions for any ~~traversed~~ binary node traversed in said traversing step and having active right and left ~~branches, and~~ branches;

generating, for each group, leaf value instructions for any ~~traversed~~ leaf node traversed in said traversing step; and

executing for each group, the generated instructions to render the graphic objects at the one or more pixel locations.

8. (Previously Presented) A method according to claim 7, wherein said traversing step traverses the expression tree, wherein the left branch of any previously traversed descendent node if the right and left branches of the previously traversed binary node are active and if the graphic object representing the descendent node on the right branch of the previously traversed binary node does not obscure the graphic object representing the descendent node on the left branch of the previously traversed binary node in the common region of the graphic objects representing the descendent nodes of the previously traversed binary node, and wherein the right branch of any previously traversed binary node is traversed to its descendent node if the right and left branches of the previously traversed binary node are active and if the graphic object representing the descendent node on the left branch of the previously traversed binary node does not obscure the graphic object representing the descendent node on the right branch of the previously traversed binary node in the common region of the graphic objects representing the descendent nodes of the previously traversed binary node.

Claim 9. (Currently Amended) A method of rendering an expression tree into a raster pixel image having a plurality of scanlines and a plurality of pixel locations on each scanline, the expression tree having a plurality of nodes comprising one or more binary nodes and a plurality of leaf nodes, wherein each binary node has a left branch to a descendent node and a right branch to another descendent node and represents a binary operation on the two descendant nodes, and wherein each node represents a graphic object having object edges, with one or more graphic objects overlapping, the overlapping graphics objects comprising a left node region, a common region, and a right node region, said method comprising the steps of:

generating a table representative of the expression tree, wherein the table comprises a plurality of records corresponding to associated binary nodes and leaf nodes, and each record of an associated binary node comprises a first field indicating whether a left region is required for operation of the operator of the associated binary node, a second field indicating whether a right region is required for operation of the operator of the associated binary node, a third field capable of indicating whether a left branch of the associated binary node is active, and a fourth field capable of indicating whether a right branch of the associated binary node is active;

determining groups of one or more pixel locations, wherein the groups are bounded by object edges;

determining, for each group, whether the left and right branches of the one or more binary nodes are active or inactive;

updating, for each group, the third and fourth fields of the table for the determined active and inactive branches;

traversing, for each group, the expression tree in accordance with the updated table wherein ~~the left branch of any previously traversed binary node is ignored unless~~ said traversing step comprises the substeps of:

checking whether the right and left branches of ~~the a~~ previously traversed binary node are active or a left node region is required for the binary operation of said previously traversed binary node and the left branch is active and the right branch is inactive of the previously traversed binary node, ~~and wherein a right branch of any previously traversed binary node is ignored unless~~ and, if so, traversing the left branch of the previously traversed binary node to the descendent node; and

checking whether the right and left branches of the previously traversed binary node are active or a right node region is required for the binary operation of the previously traversed binary node and the right branch is active and the left branch is inactive of the previously traversed binary node and, if so, traversing the right branch of the previously traversed binary node to the descending node;

generating, for each group, operator instructions for any traversed binary node having active said right and left branches, and leaf value instructions for any traversed leaf node; and  
executing, for each group, corresponding generated instructions so as to render the image.

10. (Previously Presented) A method according to claim 9,  
wherein the table further comprises for each record of an associated binary node a fifth field indicating whether the graphic object representing the descendent node on the right branch of the associated binary node obscures the graphic object representing the descendent node on the

left branch of the associated binary node in the common region of the graphic objects representing the descendent nodes of the associated binary node, and a sixth field indicating whether the graphic object representing the descendent node on the left branch of the associated binary node obscures the graphic object representing the descendent node on the right branch of the associated binary node in the common region of the graphic objects representing the descendent nodes of the associated binary node, and

wherein said traversing step traverses the expression tree in accordance with the updated table, wherein the left branch of any previously traversed binary node is traversed to its descendent node if the right and left branches of the previously traversed binary node are active and if the graphic object representing the descendent node on the right branch of the previously traversed binary node does not obscure the graphic object representing the descendent node on the left branch of the previously traversed binary node in the common region of the graphic objects representing the descendent nodes of the previously traversed binary node, and wherein the right branch of any previously traversed binary node is traversed to its descendent node if the right and left branches of the previously traversed binary node are active and if the graphic object representing the descendent node on the left branch of the previously traversed binary node does not obscure the graphic object representing the descendent node on the right branch of the previously traversed binary node in the common region of the graphic objects representing the descendent nodes of the previously traversed binary node.

11. (Previously Presented) A method according to claim 10, wherein the fifth and sixth fields are used to implement a CLIP IN or a CLIP OUT operation.

12. (Currently Amended) An apparatus for ~~generating instructions for~~ rendering a directed acyclic graph into a raster pixel image having a plurality of pixel locations, the directed acyclic graph comprising one or more parent nodes and one or more leaf nodes, each parent node representing an operator and having branches to respective descendent nodes, and each leaf node representing a graphic object having object edges, said apparatus comprising:

means for determining groups of one or more pixel locations, wherein the groups are bounded by the object edges;

means for determining, for each group, a portion of the directed acyclic graph in accordance with activities of the operators, wherein the portion of the directed acyclic graph is that portion which passes data up the directed acyclic graph; ~~and~~

means for traversing, for each group, the determined portion of the directed acyclic graph;

means for generating, for each group, instructions for the ~~determined~~ traversed portion of the directed acyclic graph, wherein operator instructions are generated for those operators of the ~~determined~~ traversed portion of the directed acyclic graph having active branches and wherein leaf instructions are generated for those graphic objects which are active at the group of one or more pixel locations; and

means for executing, for each group, the generated instructions to render the graphic objects at the one or more pixel locations.

13. (Previously Presented) An apparatus according to claim 12, wherein said apparatus further comprises means for generating a table for storing data concerning the activity of the operators and the activity of the branches of the parent nodes.



14. (Previously Presented) An apparatus according to claim 13, wherein said means for determining groups comprises means for updating, for each group, the data stored in the generated table.

15. (Cancelled)

16. (Previously Presented) An apparatus according to claim 12, wherein the directed acyclic graph is an expression tree.

17. (Previously Presented) An apparatus according to claim 12, wherein the parent nodes represent binary operators.

18. (Currently Amended) An apparatus for ~~generating instructions for~~ rendering an expression tree into a raster pixel image having a plurality of pixel locations, the expression tree having a plurality of nodes comprising one or more binary nodes and a plurality of leaf nodes, wherein each binary node has a left branch to a descendent node and a right branch to another descendent node and represents a binary operation on the two descendant nodes, and wherein each node represents a graphic object having object edges, with one or more graphic objects overlapping, the overlapping graphics objects comprising a left node region, a common region, and a right node region, said apparatus comprising:

means for determining groups of one or more pixel locations, wherein the groups are bounded by the object edges;

means for determining, for each group, whether the left and right branches of one or more binary nodes are active or inactive;

means for traversing, for each group, the expression tree, wherein ~~the left branch of any previously traversed binary node is ignored unless~~ said means for traversing comprises:

means for checking whether the right and left branches of ~~the~~ a previously traversed binary node are active or a left node region is required for the binary operation of the previously traversed binary node and the left branch is active and the right branch is inactive of the previously traversed binary node; node and, if so, traversing the left branch of the previously traversed binary node to the descendent node; and ~~wherein a right branch of any previously traversed binary node is ignored unless~~

means for checking whether the right and left branches of the previously traversed binary node are active or a right node region is required for the binary operation of the previously traversed binary node and the right branch is active and the left branch is inactive of the previously traversed binary node and, if so, traversing the right branch of the previously traversed binary node to the descendent node; and

means for generating, for each group, operator instructions for any ~~traversed~~ binary node traversed by said traversing means and having active right and left branches, and

means for generating, for each group, leaf value instructions for any ~~traversed~~ leaf node traversed by said traversing means; and

means for executing, for each group, the generated instructions to render the graphic objects at the one or more pixel locations.

19. (Previously Presented) An apparatus according to claim 18, wherein said traversing means traverses the expression tree, wherein the left branch of any previously traversed said binary node is traversed to its descendent node if the right and left branches of the previously traversed binary node are active and if the graphic object representing the descendent node on the right branch of the previously traversed binary node does not obscure the graphic object representing the descendent node on the left branch of the previously traversed binary node in the common region of the graphic objects representing the descendent nodes of the previously traversed binary node, and wherein the right branch of any previously traversed binary node is traversed to its descendent node if the right and left branches of the previously traversed binary node are active and if the graphic object representing the descendent node on the left branch of the previously traversed binary node does not obscure the graphic object representing the descendent node on the right branch of the previously traversed binary node in the common region of the graphic objects representing the descendent nodes of the previously traversed binary node.

20. (Currently Amended) An apparatus for rendering an expression tree into a raster pixel image having a plurality of scanlines and a plurality of pixel locations on each scanline, the expression tree having a plurality of nodes comprising one or more binary nodes and a plurality of leaf nodes, wherein each binary node has a left branch to a descendent node and a right branch to another descendent node and represents a binary operation on the two descendant nodes, and wherein each node represents a graphic object having object edges, with one or more graphic

objects overlapping, the overlapping graphics objects comprising a left node region, a common region, and a right node region, said apparatus comprising:

means for generating a table representative of the expression tree, wherein the table comprises a plurality of records corresponding to associated binary nodes and leaf nodes, and each record of an associated binary node comprises a first field indicating whether a left region is required for operation of the operator of the associated binary node, a second field indicating whether a right region is required for operation of the operator of the associated binary node, a third field capable of indicating whether a left branch of the associated binary node is active, and a fourth field capable of indicating whether a right branch of the associated binary node is active;

means for determining groups of one or more pixel locations, wherein the groups are bounded by the object edges;

means for determining, for each group, whether the left and right branches of the one or more binary nodes are active or inactive;

means for updating, for each group, the third and fourth fields of the table for the determined active and inactive branches;

means for traversing, for each group, the expression tree in accordance with the updated table wherein ~~the left branch of any previously traversed binary node is ignored unless~~ said

means for traversing comprises:

means for checking whether the right and left branches of ~~the~~ a previously traversed binary node are active or a left node region is required for the binary operation of the previously traversed binary node and the left branch is active and the right branch is inactive of the previously traversed binary node, ~~and wherein a right branch of any previously traversed binary~~

node is ignored unless node and, if so, traversing the left branch of the previously traversed node to the descendent node; and

means for checking whether the right and left branches of the previously traversed binary node are active or a right node region is required for the binary operation of the previously traversed binary node and the right branch is active and the left branch is inactive of the previously traversed binary node and, if so, traversing the right branch of the previously traversed node to the descendent node;

means for generating, for each group, operator instructions for any traversed binary node having active said right and left branches, and leaf value instructions for any traversed leaf node; and

means for executing, for each group, corresponding generated instructions so as to render the image.

21. (Previously Presented) An apparatus according to claim 20, wherein the table further comprises for each record of an associated binary node a fifth field indicating whether the graphic object representing the descendent node on the right branch of the associated binary node obscures the graphic object representing the descendent node on the left branch of the associated binary node in the common region of the graphic objects representing the descendent nodes of the associated binary node, and a sixth field indicating whether the graphic object representing the descendent node on the left branch of the associated binary node obscures the graphic object representing the descendent node on the right branch of

the associated binary node in the common region of the graphic objects representing the descendent nodes of the associated binary node, and

wherein said traversing means traverses the expression tree in accordance with the updated table, wherein the left branch of any previously traversed binary node is traversed to its descendent node if the right and left branches of the previously traversed binary node are active and if the graphic object representing the descendent node on the right branch of the previously traversed binary node does not obscure the graphic object representing the descendent node on the left branch of the previously traversed binary node in the common region of the graphic objects representing the descendent nodes of the previously traversed binary node, and wherein the right branch of any previously traversed binary node is traversed to its descendent node if the right and left branches of the previously traversed binary node are active and if the graphic object representing the descendent node on the left branch of the previously traversed binary node does not obscure the graphic object representing the descendent node on the right branch of the previously traversed binary node in the common region of the graphic objects representing the descendent nodes of the previously traversed binary node.

22. (Previously Presented) An apparatus according to claim 21, wherein the fifth and sixth fields are used to implement a CLIP IN or a CLIP OUT operation.

23. (Currently Amended) A computer readable medium comprising a computer program for generating instructions for rendering a directed acyclic graph into a raster pixel image having a plurality of pixel locations, the directed acyclic graph comprising one or more

parent nodes and one or more leaf nodes, each parent node representing an operator and having branches to respective descendent nodes, and each leaf node representing a graphic object having object edges, said computer program comprising:

code for determining groups of one or more pixel locations, wherein the groups are bounded by the object edges;

code for determining, for each group, a portion of the directed acyclic graph in accordance with activities of the operators, wherein the portion of the directed acyclic graph is that portion which passes data up the directed acyclic graph; and

code for traversing, for each group, the determined portion of the directed acyclic graph;

code for generating, for each group, instructions for the ~~determined~~ traversed portion of the directed acyclic graph, wherein operator instructions are generated for those operators of the ~~determined~~ traversed portion of the directed acyclic graph having active branches and wherein leaf instructions are generated for those graphic objects which are active at the group of one or more pixel locations; and

code for executing, for each group, the generated instructions to render the graphic objects at the one or more pixel locations.

24. (Previously Presented) A computer readable medium according to claim 23, wherein said computer program further comprises code for generating a table for storing data concerning the activity of the operators and the activity of the branches of the parent nodes.

25. (Previously Presented) A computer readable medium according to claim 24, wherein said code for determining groups comprises code for updating, for each group, the data stored in the generated table.

26. (Cancelled)

27. (Previously Presented) A computer readable medium according to claim 23, wherein the directed acyclic graph is an expression tree.

28. (Previously Presented) A computer readable medium according to claim 23, wherein the parent nodes represent binary operators.

29. (Currently Amended) A computer readable medium comprising a computer program for ~~generating instructions for~~ rendering an expression tree into a raster pixel image having a plurality of pixel locations, the expression tree having a plurality of nodes comprising one or more binary nodes and a plurality of leaf nodes, wherein each binary node has a left branch to a descendent node and a right branch to another descendent node and represents a binary operation on the two descendant nodes, and wherein each node represents a graphic object having object edges, with one or more graphic objects overlapping, the overlapping graphics objects comprising a left node region, a common region, and a right node region, said computer program comprising:



code for determining groups of one or more pixel locations, wherein the groups are bounded by the object edges;

code for determining, for each group, whether the left and right branches of the one or more binary nodes are active or inactive;

code for traversing, for each the expression tree, wherein ~~the left branch of any previously traversed binary node is ignored unless~~ said code for traversing comprises:

code for checking whether the right and left branches of the a previously traversed binary node are active or a left node region is required for the binary operation of the previously traversed binary node and the left branch is active and the right branch is inactive of the previously traversed binary node, and wherein a right branch of any previously traversed binary node is ignored unless node and, if so, traversing the left branch of the previously traversed binary node to the descendent node; and

code for checking whether the right and left branches of the previously traversed binary node are active or a right node region is required for the binary operation of the previously traversed binary node and the right branch is active and the left branch is inactive of the previously traversed binary node; and node and, if so, traversing the right branch of the previously traversed binary node to the descendent node;

code for generating, for each group, operator instructions for any ~~traversed~~ binary node traversed by said code for traversing and having active right and left branches, and

code for checking for each group, leaf value instructions for any ~~traversed~~ leaf node traversed by said code for traversing; and

code for executing, for each group, the generated instructions to render the graphic objects at the one or more pixel locations.

30. (Previously Presented) A computer readable medium according to claim 29, wherein said traversing code traverses the expression tree, wherein the left branch of any previously traversed binary node is traversed to its descendent node if the right and left branches of the previously traversed binary node are active and if the graphic object representing the descendent node on the right branch of the previously traversed binary node does not obscure the graphic object representing the descendent node on the left branch of the previously traversed binary node in the common region of the graphic objects representing the descendent nodes of the previously traversed binary node, and wherein the right branch of any previously traversed binary node is traversed to its descendent node if the right and left branches of the previously traversed binary node are active and if the graphic object representing the descendent node on the left branch of the previously traversed binary node does not obscure the graphic object representing the descendent node on the right branch of the previously traversed binary node in the common region of the graphic objects representing the descendent nodes of the previously traversed binary node.

31. (Currently Amended) A computer readable medium comprising a computer program for rendering an expression tree into a raster pixel image having a plurality of scanlines and a plurality of pixel locations on each scanline, the expression tree having a plurality of nodes comprising one or more binary nodes and a plurality of leaf nodes, wherein each binary node has

a left branch to a descendent node and a right branch to another descendent node and represents a binary operation on the two descendant nodes, and wherein each node represents a graphic object having object edges, with one or more graphic objects overlapping, the overlapping graphics objects comprising a left node region, a common region, and a right node region, said computer program comprising:

code for generating a table representative of the expression tree, wherein the table comprises a plurality of records corresponding to associated binary nodes and leaf nodes, and each record of an associated binary node comprises a first field indicating whether a left region is required for operation of the operator of the associated binary node, a second field indicating whether a right region is required for operation of the operator of the associated binary node, a third field capable of indicating whether a left branch of the associated binary node is active, and a fourth field capable of indicating whether a right branch of the associated binary node is active;

code for determining groups of one or more pixel locations, wherein the groups are bounded by the object edges;

code for determining, for each group, whether the left and right branches of the one or more binary nodes are active or inactive;

code for updating, for each group, the third and fourth fields of the table for the determined active and inactive branches;

code for traversing, for each group, the expression tree in accordance with the updated table wherein ~~the left branch of any previously traversed binary node is ignored unless~~ said code for traversing comprises:

code for checking whether the right and left branches of the a previously traversed binary node are active or a left node region is required for the binary operation of the previously traversed binary node and the left branch is active and the right branch is inactive of the previously traversed binary node, and wherein a right branch of any previously traversed binary node is ignored unless node and, if so, traversing the left branch of the previously traversed binary node to the descendent node; and

code for checking whether the right and left branches of the previously traversed binary node are active or a right node region is required for the binary operation of the previously traversed binary node and the right branch is active and the left branch is inactive of the previously traversed binary node and, if so, traversing the right branch of the previously traversed binary node to the descendent node;

code for generating, for each group, operator instructions for any traversed binary node having active right and left branches, and leaf value instructions for any traversed leaf node; and

code for executing, for each group, corresponding generated instructions so as to render the image.

32. (Previously Presented) A computer readable medium according to claim 31, wherein the table further comprises for each record of an associated binary node a fifth field indicating whether the graphic object representing the descendent node on the right branch of the associated binary node obscures the graphic object representing the descendent node on the left branch of the associated binary node in the common region of the graphic objects representing the descendent nodes of the associated binary node, and a sixth field indicating whether the

graphic object representing the descendent node on the left branch of the associated binary node obscures the graphic object representing the descendent node on the right branch of the associated binary node in the common region of the graphic objects representing the descendent nodes of the associated binary node, and

wherein said traversing means traverses the expression tree in accordance with the updated table, wherein the left branch of any previously traversed binary node is traversed to its descendent node if the right and left branches of the previously traversed binary node are active and if the graphic object representing the descendent node on the right branch of the previously traversed binary node does not obscure the graphic object representing the descendent node on the left branch of the previously traversed binary node in the common region of the graphic objects representing the descendent nodes of the previously traversed binary node, and wherein the right branch of any previously traversed binary node is traversed to its descendent node if the right and left branches of the previously traversed binary node are active and if the graphic object representing the descendent node on the left branch of the previously traversed binary node does not obscure the graphic object representing the descendent node on the right branch of the previously traversed binary node in the common region of the graphic objects representing the descendent nodes of the previously traversed binary node.

33. (Previously Presented) A computer program according to claim 32, wherein the fifth and sixth fields are used to implement a CLIP IN or a CLIP OUT operation.